QUALITY INSPECTION TECHNICAL MANUAL
SEALING PIPE THREAD (TAPERED)

R/Rc/Rp (BSP Taper) & NPT/NPTF — Inspection & Acceptance

Document No.:	KFP-QIM-THD-003
Revision:	F
Effective Date:	2026-03-20
Next Review Date:	2027-03-20
Classification:	Internal Technical Document
Scope:	Tapered pipe threads for pressure-tight joints. ISO 7-1/7-2 (R/Rc/Rp) and ASME B1.20.1/.3/.5/.7 (NPT/NPTF). Sizes 1/16″–4″. Does NOT cover parallel/non-sealing pipe threads (see THD-004).

IATF 16949 | ISO 9001 | ISO 14001 Certified Facility

Revision History

Rev.	Date	Description & Triggering Standards	Author	Approved
A	2005-06	Initial release. Based on ISO 7-1:1994, ISO 7-2:2000, ASME B1.20.1-1983 (R2001), ASME B1.20.3-1976 (R2003). Established L1/L2 gauge plane inspection.	Quality Eng.	Quality Dir.
B	2009-03	Added NPTF dryseal provisions per ASME B1.20.3. Added taper verification method using taper gauge and CMM. Expanded torque sealing test requirements.	Quality Eng.	Quality Dir.
C	2013-09	Updated to ISO 7-1:2014 (thread profile tolerances tightened). Added thread sealant compatibility testing for zinc-nickel coated pipe fittings.	Quality Eng.	Quality Dir.
D	2016-11	Added 100% optical sorting for pipe fitting thread presence check. Enhanced SPC for taper angle measurement.	Quality Eng.	Quality Dir.
E	2019-08	Added ASME B1.20.5-1991 (R2003) and B1.20.7-1991 (R2003) gauge references. Expanded NPTF truncation inspection.	Quality Eng.	Quality Dir.
F	2026-03	Comprehensive review. Verified all normative references current. Added: CMM taper scanning protocol, post-coating gauge verification for plated pipe threads, short-batch protocols, packaging audit for pipe fittings, hydraulic pressure test cross-reference.	Quality Eng.	Quality Dir.

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1. Scope and Normative References

1.1 Scope

This manual covers tapered pipe threads used for pressure-tight sealing connections in hydraulic, pneumatic, and fluid transfer systems. Two systems are in scope:

(a) ISO system: R (external taper), Rc (internal taper), Rp (internal parallel mating with R external). Per ISO 7-1:2014 and ISO 7-2:2000.

(b) ASME system: NPT (National Pipe Taper), NPTF (National Pipe Taper Fuel / Dryseal). Per ASME B1.20.1 and B1.20.3.

(c) Size range: 1/16″ through 4″ nominal pipe size.

1.2 Exclusions

Non-sealing parallel pipe threads G series (KFP-QIM-THD-004), straight mechanical pipe threads NPS, and all non-pipe thread forms.

1.3 Normative References

Standard	Title / Scope
ISO 7-1:2014	Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation (R/Rc/Rp)
ISO 7-2:2000	Pipe threads — Part 2: Verification by means of limit gauges (R/Rc/Rp gauging)
ASME B1.20.1-1983 (R2001)	Pipe Threads, General Purpose (Inch) — NPT thread form, dimensions, tolerances
ASME B1.20.3-1976 (R2003)	Dryseal Pipe Threads (Inch) — NPTF thread form for pressure-tight joints without sealant
ASME B1.20.5-1991 (R2003)	Gauging for Pipe Threads (NPT)
ASME B1.20.7-1991 (R2003)	Gauging for Dryseal Pipe Threads (NPTF)
ISO 16047:2005	Torque/clamp force testing

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2. Thread Geometry

2.1 Taper Specification

Both ISO R and ASME NPT systems use a taper of 1:16 (measured on diameter), which equals 1°47′24″ half-angle. This taper creates the wedging action that produces the seal.

Parameter	ISO R system	ASME NPT/NPTF
Thread angle	55° (Whitworth form)	60° (American National form)
Taper	1:16 on diameter	1:16 on diameter (same)
Root / crest	Rounded root & crest (R = 0.137P)	Flat root & crest (NPT); truncated (NPTF)
Pitch designation	TPI (same values as NPT for same nom. size)	TPI: 27 (1/16″) to 8 (4″)
Sealing mechanism	Metal-to-metal wedge + sealant (R/Rc); or with Rp parallel nut	NPT: sealant required; NPTF: metal-to-metal dryseal (no sealant)

> **IMPORTANT:** ISO R (55°) and ASME NPT (60°) are NOT interchangeable. Cross-mating R with NPT will cause leakage. Always verify system designation before inspection.

2.2 Key Dimensional Parameters

(a) L1 (hand-tight engagement length): distance from end of pipe to the gauge plane where the L1 gauge is flush. This is the primary inspection dimension.

(b) L2 (effective thread length): wrench-tight engagement. L2 = L1 + additional turns per specification.

(c) Taper: verified by the differential measurement between L1 and L3 plug gauge positions, or by CMM taper scan.

(d) NPTF specific: truncation at crest and root must be within specified limits to achieve dryseal. Verified by L1, L3, and truncation (crest/root) gauges.

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3. Gauge Inspection System

3.1 NPT Gauging (per ASME B1.20.5)

Gauge	Function	Acceptance Criteria
L1 Plug Gauge (internal NPT)	Verify hand-tight engagement depth. Gauge face should be flush ±1 turn with end of fitting.	Gauge face flush with pipe end ±1 turn. Short: undersize thread. Long: oversize thread.
L1 Ring Gauge (external NPT)	Verify external taper thread hand-tight engagement.	Pipe end flush with ring gauge face ±1 turn.
L3 Plug Gauge (NPTF internal)	Verify dryseal truncation and effective length.	L3 plug must NOT enter beyond L3 face (max material check for dryseal).
Truncation Gauges (NPTF)	Verify crest and root truncation within dryseal limits.	Crest/root truncation within ASME B1.20.3 limits for the size/TPI combination.

3.2 ISO R Gauging (per ISO 7-2)

ISO 7-2 gauging follows the same L1 principle. The gauge plane position determines conformance. Key difference: ISO R gauges have 55° thread angle — they must NOT be used on NPT threads.

3.3 Taper Verification by CMM

(a) Scan thread profile along helix for minimum 3 full revolutions.

(b) Extract diameter values at two axial positions separated by a known distance.

(c) Calculate taper: T = (D1 − D2) / L × 1000 (for mm) or × 1 (for inches). Target: 62.5 mm/m ± tolerance (= 1:16).

(d) CMM probe: use conical tip or small-radius ball (R ≤ 0.5 mm) to access thread root.

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4. Inspection Equipment

Equipment	Specification	Parameters Measured	Application
L1/L3 plug & ring gauges	Per ASME B1.20.5/7 and ISO 7-2	Hand-tight engagement, taper, truncation	100% inspection
CMM	Acc. ±0.001 mm; taper scan capability	Taper angle, pitch dia., pitch, thread profile	FAI, PPAP, audit
Taper comparator	Sine bar + dial indicator setup	Taper angle verification (1:16)	In-process check
Profile projector	10×–50× with taper overlay	Thread angle (55° vs 60°), root form	Thread form verification
GO/NO-GO (pipe)	Per applicable standard	Functional fit	Production floor
Pressure test rig	Hydrostatic to 1.5× working pressure	Seal integrity under pressure	PPAP / customer spec
AMETEK OES	Multi-element	Material verification	Incoming

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5. Inspection Procedures

5.1 Material & FAI

Incoming material verification per THD-001 Section 6.1. FAI follows THD-001 structure with pipe-thread-specific items: L1 gauge check, taper measurement, thread angle verification (55° or 60°), and for NPTF: truncation gauge check.

5.2 In-Process SPC

(a) L1 gauge check: every 50 pcs (CNC machined fittings) or every 200 pcs (cold-formed fittings).

(b) Taper: CMM or taper comparator at 1×/hour. SPC X̄-R chart.

(c) Thread angle: profile projector check at setup and every 500 pcs.

5.3 Final Inspection

(a) 100% L1 gauge check (hand-tight engagement).

(b) For NPTF: 100% L3 gauge + truncation gauge check.

(c) Coated pipe threads: re-gauge AFTER coating. Taper thread sealant interaction must be verified if customer specifies anaerobic sealant or PTFE tape compatibility.

(d) Pressure test: per customer spec or when pipe fitting is rated for pressure service. Test at 1.5× working pressure, hold 60 seconds, no leakage.

5.4 Packaging Audit

Per THD-001 Section 6.6. Additional: verify thread protector caps are installed on all pipe threads to prevent transit damage to sealing surfaces.

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Non-Conformance Handling and Disposition

Standard NC Procedure

Step	Action
1. Containment	STOP production. Segregate with RED tag. Quarantine. NCR Form KFP-NCR-001.
2. Scope	Trace to last good inspection. Re-inspect 100% of suspect window.
3. Root cause	8D/5-Why analysis. Common: tool wear, wrong setup, gauge error, material variation.
4. Disposition (MRB)	REWORK / USE-AS-IS (customer concession) / SCRAP.
5. Corrective action	Permanent fix; verify effectiveness over ≥3 production lots.
6. Customer notification	If NC product shipped: 24-hr notice + 8D per IATF 16949 §8.7.1.6.

Records, Traceability & Documentation

Record	Doc ID	Retention	Storage
Material cert (EN 10204 3.1)	Per lot	15 yr (auto) / 10 yr	QMS + archive
OES report	KFP-MAT-OES-[lot]	= material cert	QMS
FAI report	KFP-FAI-[part]-[date]	Part life + 1 yr	QMS
SPC charts	Auto-generated	Current + 2 yr	SPC database
Gauge log	KFP-GAG-LOG-[line]	Current + 1 yr	QMS
CMM thread report	KFP-CMM-THD-[part]	Part life + 1 yr	QMS + PDF
Final inspection	KFP-FIN-[lot]-[date]	15 yr (auto)	QMS
NCR / 8D	KFP-NCR-[seq]	Part life + 3 yr	QMS
Gauge cal cert	KFP-CAL-[gauge ID]	+ 2 cal cycles	QMS
PPAP package	Per customer	Part life + 1 yr EOL	QMS + portal

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Document Approval

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END OF DOCUMENT

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